

Marshall Space Flight Center

Systems Analysis

National Aeronautics and Space Administration

Mass Properties For Space Systems Standards Development

**To be Presented at 2013 Society of Allied Weight Engineers Annual Conference,
St. Louis Mo.**



Overview

- ◆ **Brief History of AIAA S-120-2006 and ISO 22010 Mass Control Standards for Space Systems**
- ◆ **Time for “Renew or Revise” for both AIAA and ISO**
- ◆ **AIAA S-120-2006 – CoS chaired by Louis Chang**
 - ◆ **Polling indicates ‘revision’ is appropriate for S-120.**
 - ◆ **Potentially to seek ANSI status**
- ◆ **ISO 22010 – chaired by Ian McNeil**
 - ◆ **Draft developed and suspended pending update to S-120.**
 - ◆ **ISO may request adoption of AIAA S-120 Rev A**



Focus Areas for Updates

◆ AIAA S-120-2006 & ISO 22010

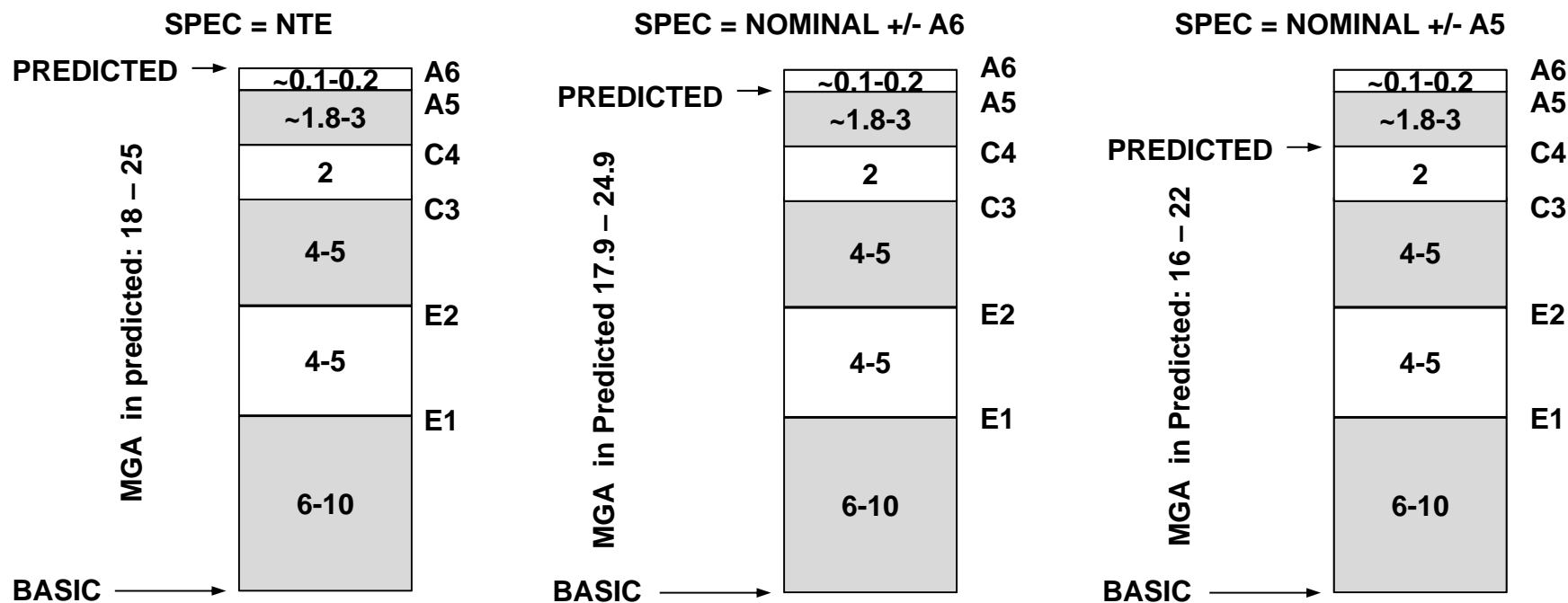
- 1. Rework use of “shall” and “should” to be more appropriate**
 - Shall is contractual language requires verification
 - Will indicates expected outcomes
 - Should indicates guidance
- 2. Clarify relationship between MGA categories A5 and A6 relative to mass specification language.**
- 3. Mass margin recommendations for LV's (does not include recommendations for non-mass concerns)**
- 4. TPM (monitoring) – articulation between Basic & Predicted Mass, Potential Changes (forecast) and Aggregate Mass Maturity by Mass Maturity Category**
- 5. MGA schedule (maturity definitions, range of values)**



Uncertainty: MGA and Specification Correlation

Expected development maturity under contract (spec) should correlate with Project/ Program Approved MGA Depletion Schedule in Mass Properties Control Plan

- ◆ If specification NTE, MGA is inclusive of Actual MGA (A5 & A6)
- ◆ If specification is not an NTE Actual MGA (e.g. nominal), then MGA values are reduced by A5 values and A5 is representative of remaining uncertainty





Mass Margin for Launch Vehicles

Table 2 — TPM - Guidelines for Mass Assessment

Program Milestone	MGA		Recommended Dry Mass Margin	
	% ¹	Grade	% ¹	Grade
ATP	> 15	Green	> 15	Green
	9 < MGA ≤ 15	Yellow	10 < Mass Margin ≤ 15	Yellow
	≤ 9	Red	≤ 10	Red
SRR	> 15	Green	> 12	Green
	9 < MGA ≤ 15	Yellow	6 < Mass Margin ≤ 12	Yellow
	≤ 9	Red	≤ 6	Red
PDR	> 12	Green	> 9	Green
	8 < MGA ≤ 12	Yellow	5 < Mass Margin ≤ 9	Yellow
	≤ 8	Red	≤ 5	Red
CDR	> 7	Green	> 5	Green
	4 < MGA ≤ 7	Yellow	3 < Mass Margin ≤ 5	Yellow
	≤ 4	Red	≤ 3	Red
Drawing Release Complete	> 3	Green	> 2	Green
	2 < MGA ≤ 3	Yellow	1 < Mass Margin ≤ 2	Yellow
	≤ 2	Red	≤ 1	Red
Final	0	Green	> 1	Green

¹ The percentages of MGA and Margin in the above chart are defined as follows:
MGA = predicted dry mass - basic dry mass
MGA % = (MGA/basic dry mass) * 100
Mass Margin % = [(allowable dry mass - predicted dry mass)/predicted dry mass] * 100

Current Verbiage in S-120 Applies to Dry Mass

Mass Margin is difference between Required Mass and Predicted Mass.

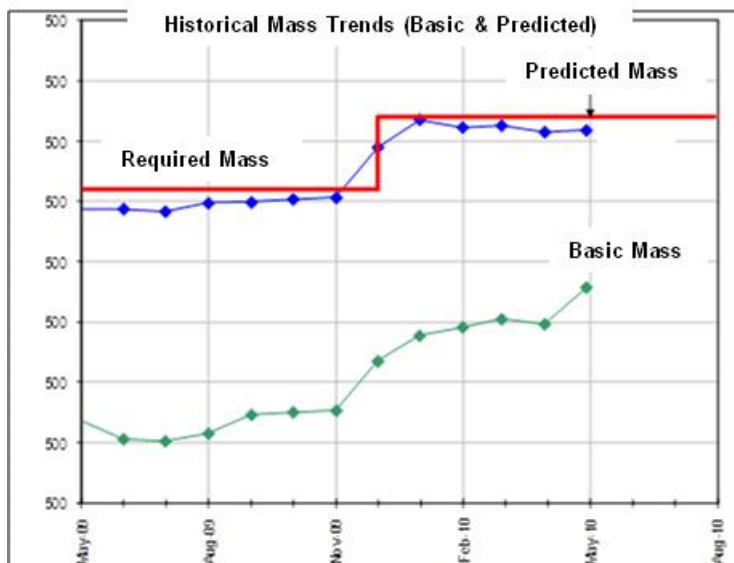
Performance Margin is difference between Predicted Performance and Required Performance

- ◆ **Performance estimates and corresponding margin should be based on Predicted Mass (and other inputs)**
- ◆ **Contractor Mass Margin reserved from Performance Margin**
- ◆ **Remaining performance margin allocated according to mass partials**



Mass Monitoring for Compliance (TPMs)

- ◆ Compliance can be evaluated effectively by comparison of three areas (preferably on a single sheet)
 - ◆ Basic and Predicted Mass (including historical trend)
 - ◆ Aggregate potential changes (threats and opportunities) which gives Mass Forecast
 - ◆ Mass Maturity by category (Estimated/Calculated/Actual)



MGA Code	Maturity	Predicted Mass	Design Status Weight % of Total
E-1	Estimated	4,100	4.1%
E-2	Layout	1,100	1.1%
C-3	Preliminary Design	20,100	20.6%
C-4	Released Design	23,900	23.9%
A-5	Existing Hardware	50,300	50.3%
A-6	Actual Mass	0.00	0.0%
A-7	Customer Furnished Equipment	0.00	0.0%

Threats and Opportunities List sorted by level of concern (likelihood, consequence) summed for Aggregate.